

Carbon black

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Carbon black is a material, today usually produced by the incomplete combustion of petroleum products. Carbon black is a form of amorphous carbon that has an extremely high surface area to volume ratio, and as such it is one of the first nanomaterials to find common use. It is similar to soot but with a much higher surface area to volume ratio. Carbon black is often used as a pigment and reinforcement in rubber and plastic products. It is known to be carcinogenic and harmful to the respiratory tract if inhaled, because it contains large amounts of Polycyclic aromatic hydrocarbons.

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Common uses

The most common usage [70%] of carbon black is as a pigment and reinforcing phase in automobile tires. Carbon black also helps conduct heat away from the tread and belt area of the tire, reducing thermal damage and increasing tire life. Carbon black particles are also employed in some radar absorbent materials and in printer toner.

Total production in 2006 is expected to be about 78932789 kilotonnes. About 20% of world production goes into belts, hoses, and other rubber goods. The balance is used in inks and as a pigment for products other than tyres.

Reinforcing carbon blacks

The highest volume use of carbon black is as a reinforcing filler in rubber products, especially tires. While a pure gum vulcanizate of SBR has a tensile strength of no more than 2.5 MPa, and almost nonexistent abrasion resistance, compounding it with 50% of its weight of carbon black improves its tensile strength and wear resistance as shown in the below table.

| Types of carbon black used in tires | | | | | | |
|-------------------------------------|---------|-------------|------------------|----------------------|------------------------------|----------------------------|
| Name | Abbrev. | ASTM Desig. | Particle Size nm | Tensile Strength MPa | Relative Laboratory Abrasion | Relative Roadwear Abrasion |
| Super Abrasion Furnace | SAF | N110 | 20-25 | 25.2 | 1.35 | 1.25 |
| Intermediate SAF | ISAF | N220 | 24-33 | 23.1 | 1.25 | 1.15 |
| High Abrasion Furnace | HAF | N330 | 28-36 | 22.4 | 1.00 | 1.00 |
| Easy Processing Channel | EPC | N300 | 30-35 | 21.7 | 0.80 | 0.90 |
| Fast Extruding Furnace | FEF | N550 | 39-55 | 18.2 | 0.64 | 0.72 |
| High Modulus Furnace | HMF | N683 | 49-73 | 16.1 | 0.56 | 0.66 |
| Semi-Reinforcing Furnace | SRF | N770 | 70-96 | 14.7 | 0.48 | 0.60 |
| Fine Thermal | FT | N880 | 180-200 | 12.6 | 0.22 | -- |
| Medium Thermal | MT | N990 | 250-350 | 9.8 | 0.18 | -- |

Practically all rubber products where tensile and abrasion wear properties are crucial use carbon black, so they are black in color. Where physical properties are important but colors other than black are desired, such as white tennis shoes, precipitated or fumed silica is a decent competitor to carbon black in reinforcing ability. Silica based fillers are also gaining market share in automotive tires because they provide better fuel efficiency due to a lower rolling loss compared to carbon black filled tires. Traditionally silica

fillers had worse abrasion wear properties, but the technology has gradually improved to where they can match carbon black abrasion performance.

Pigment

Carbon black (Colour Index International, PBL-7) is the name of a common black pigment, traditionally produced from charring organic materials such as wood or bone. It consists of pure elemental carbon, and it appears black because it reflects almost no light in the visible part of the spectrum. It is known by a variety of names, each of which reflects a traditional method for producing carbon black:

- Ivory black was traditionally produced by charring ivory or animal bones (see bone char).
- Vine black was traditionally produced by charring desiccated grape vines and stems.
- Lamp black was traditionally produced by collecting soot, also known as lampblack, from oil lamps.

Newer methods of producing carbon black have superseded these traditional sources, although some materials are still produced using traditional methods, for artisanal purposes.

Surface Chemistry of Carbon Black

All carbon blacks have chemisorbed oxygen complexes (i.e., carboxylic, quinonic, lactonic, phenolic groups and others) on their surfaces to varying degrees depending on the conditions of manufacture. These surface oxygen groups are collectively referred to as volatile content. It is also known to be a non-conductive material due to its' volatile content.

The coatings and inks industries prefer grades of carbon black that are acid oxidized. Acid is sprayed in high temperature dryers during the manufacturing process to change the inherent surface chemistry of the black. The amount of chemically-bonded oxygen on the surface area of the black is increased to enhance performance characteristics.

See also

- Activated carbon

References

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